Power System Reliability Loss of Load Studies

SRT Webinar – February 28, 2013
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Outline

- Overview of the Modeling
- Metrics: LOLP and Tail Event Evaluation
- Data Changes required for 2025 Studies
- Alternatives model/analysis results
- Alternatives summary
- Components model/analysis results
- Components summary

Overview of the Modeling

- Start with the Northwest Power and Conservation Council's (Council) 2017 Resource Adequacy Assessment (published in December 2012)
- The Assessment uses the Genesys Model which is a representation of the PNW Power System
  - Hourly stochastic model with key variables of water supply; temperature effected loads and wind generation, and forced outages of thermal power plants
  - Model dispatches hydro and thermal resources to meet load given random wind generation profiles

Overview of the Modeling (cont'd)

- Loss of Load: a condition where the load is greater than the ability of resources to serve it
- 5,390 yearly simulations are drawn with stochastic load and wind generation profiles, forced outages, and sequential water sequences (modified flows)
- The model keeps track of Loss of Load on an hourly basis

Metric 1: Loss-of-Load Probability Metric and Standard

- The **metric** is the loss-of-load probability (LOLP): The LOLP is assessed by dividing the number of simulations with loss of load by the total number of simulations
- The Council has adopted a **standard** that for an adequate power supply no more than 5% of games can have any loss of load

Metric 2: Tail Event Evaluation

- The LOLP metric only gives information on the probability of occurrence of a curtailment
- It does not give you magnitude or duration
- Monthly duration curves sort games with curtailments by their magnitude (expressed in megawatt-months)
- In all the alternatives, the month of January had the highest probability and the largest amounts of curtailments
- Examination of January curtailments between alternatives compared to RC-CC (given the same build out resources) is useful to measure risk between the alternatives

Data Changes Made to the 2017 Study to reflect 2025

- **Region achieves 6th Power Plan Conservation:** 2017 regional hourly loads escalated 0.6% per year out to 2025 (load increase net of conservation)
- **State Renewable Portfolio Standards are met:** Wind capacity increased by 6,100 MW (added to existing 4,266 MW for a total of 10,366 MW)
- **Coal Plant Closures:** Removed Boardman, Centralia 1 and Centralia 2 coal plants (total of 1,775 MW)
- For the 1A-TT study, the Canadian Entitlement is removed (436 aMW of energy and 1,324 MW of Capacity)

LOLP Results (Alternatives)

Alternatives	LOLP	MW of CTs required to reach 5% LOLP
2A-TT	27.5%	3,725 MW
2A-TC	27.9%	3,665 MW
2B-TC	28.5%	3,735 MW
RC-CC	28.3%	3,450 MW

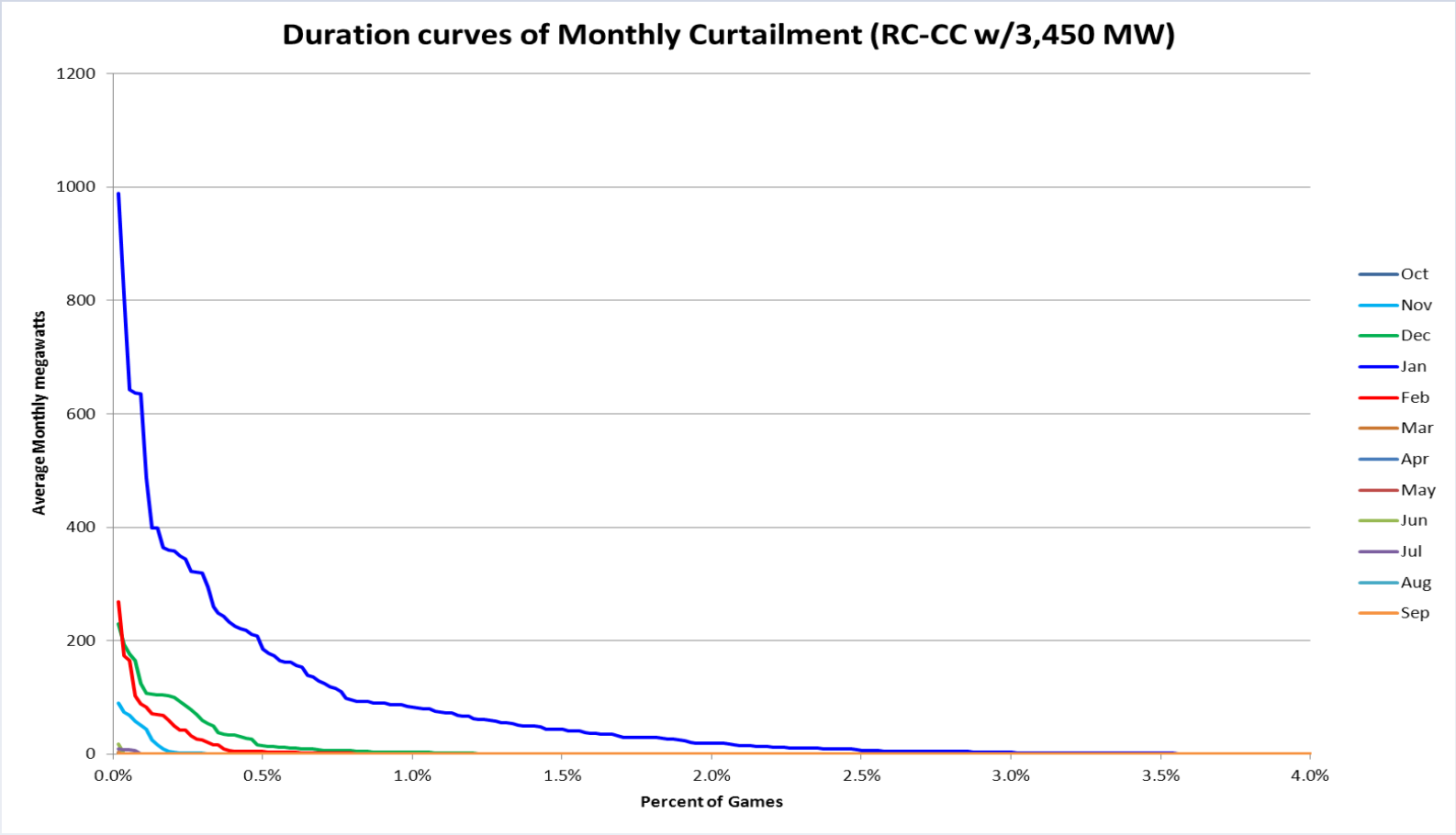
- Even with 6th Power Plan Conservation and new Renewable Portfolio Standard renewables, because of the coal plant closures and load growth the LOLP for the alternatives are between 27.5 to 28.5% - way above the 5% standard
- To get the LOLP alternatives down to 5% requires the addition of 3,450 to 3,725 MW of combustion turbines (CT)
- The RC-CC required the fewest amount of CTs (3,450 MW) and the 2B-TC required the most (3,735 MW)

LOLP Results (Alternatives)

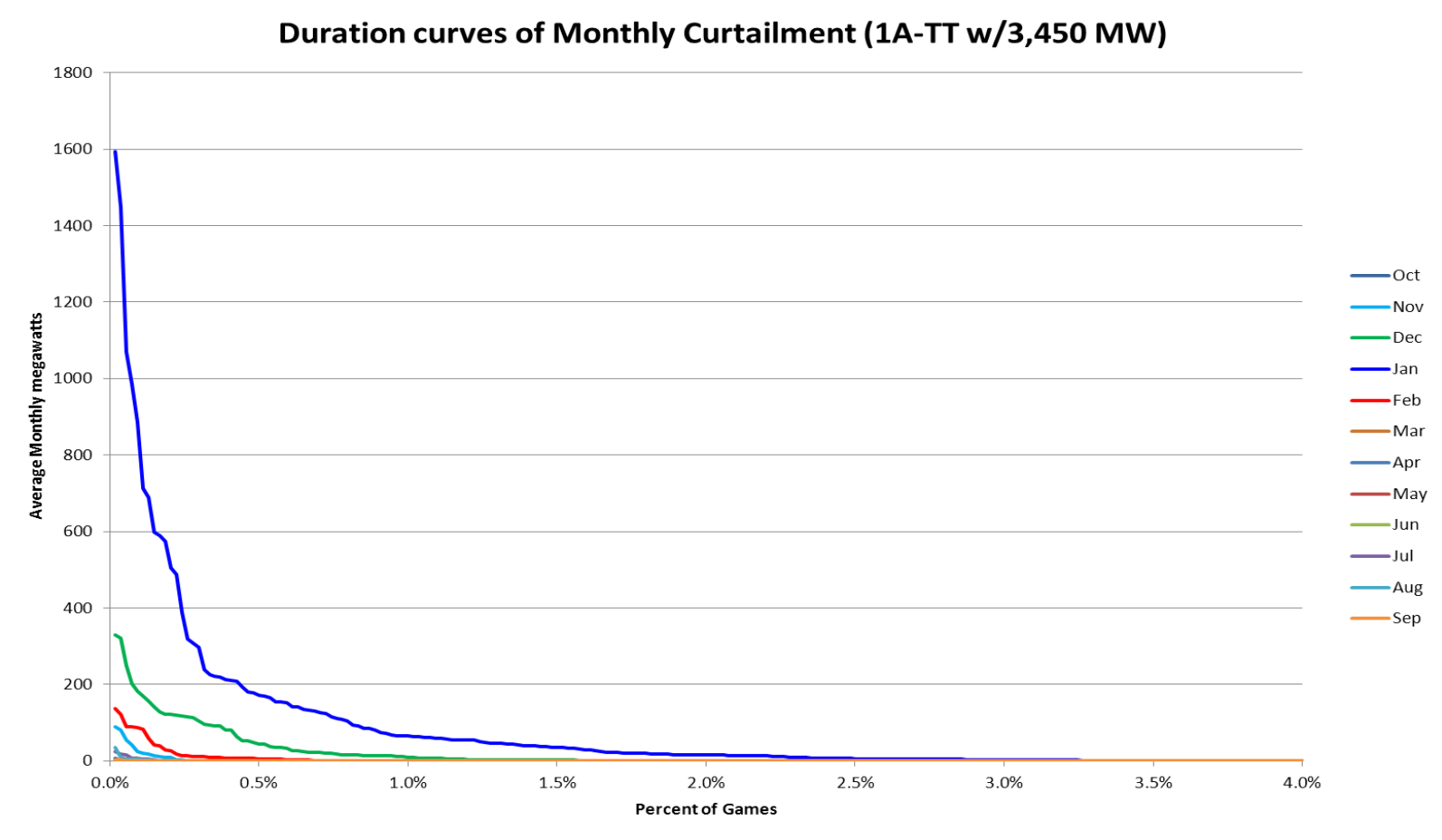
Alternative	CT MW Added	LOLP with 3,450 MW CT Added
2A-TT	3,450 MW	5.47%
2A-TC	3,450 MW	5.34%
2B-TC	3,450 MW	5.57%
RC-CC	3,450 MW	5.00%

- RC-CC case required the least amount of CT to reach 5% LOLP (3,450 MW)
- With 3,450 MW of CTs, the 2B-TC had the highest LOLP (5.57%)

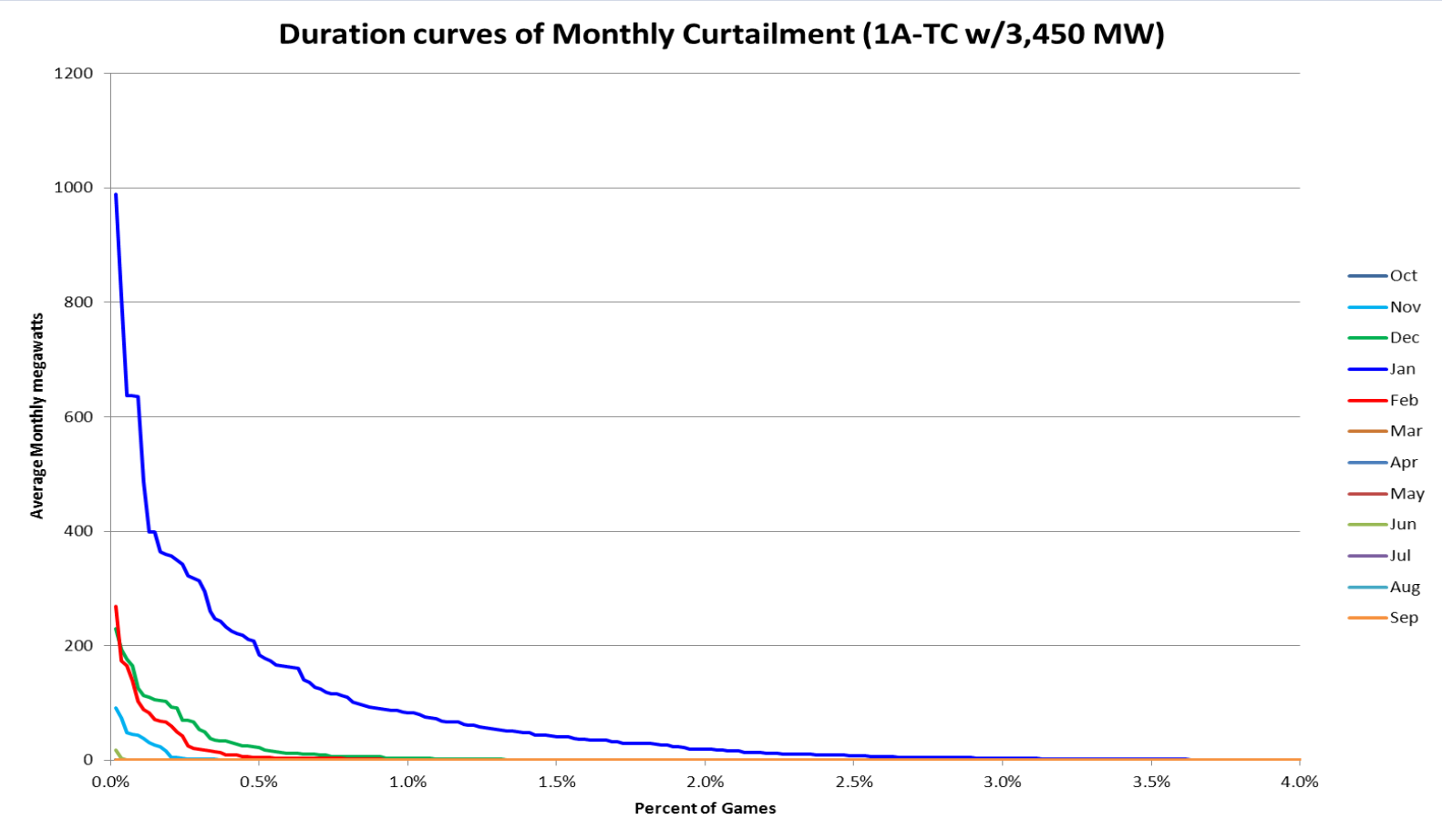
Monthly Duration Curves (RC-CC with 3,450 MW added)



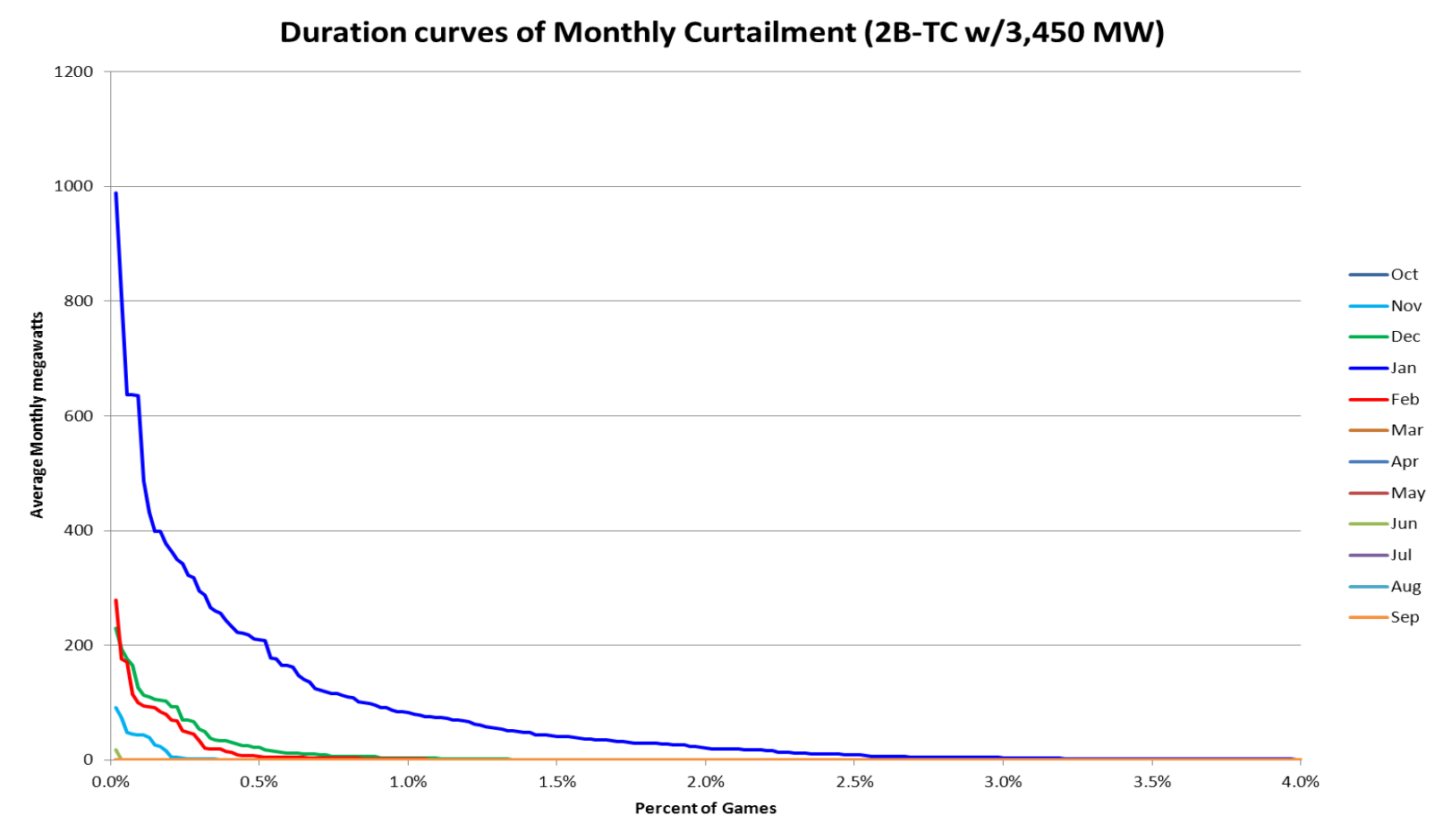
Monthly Duration Curves (2A-TT with 3,450 MW added)



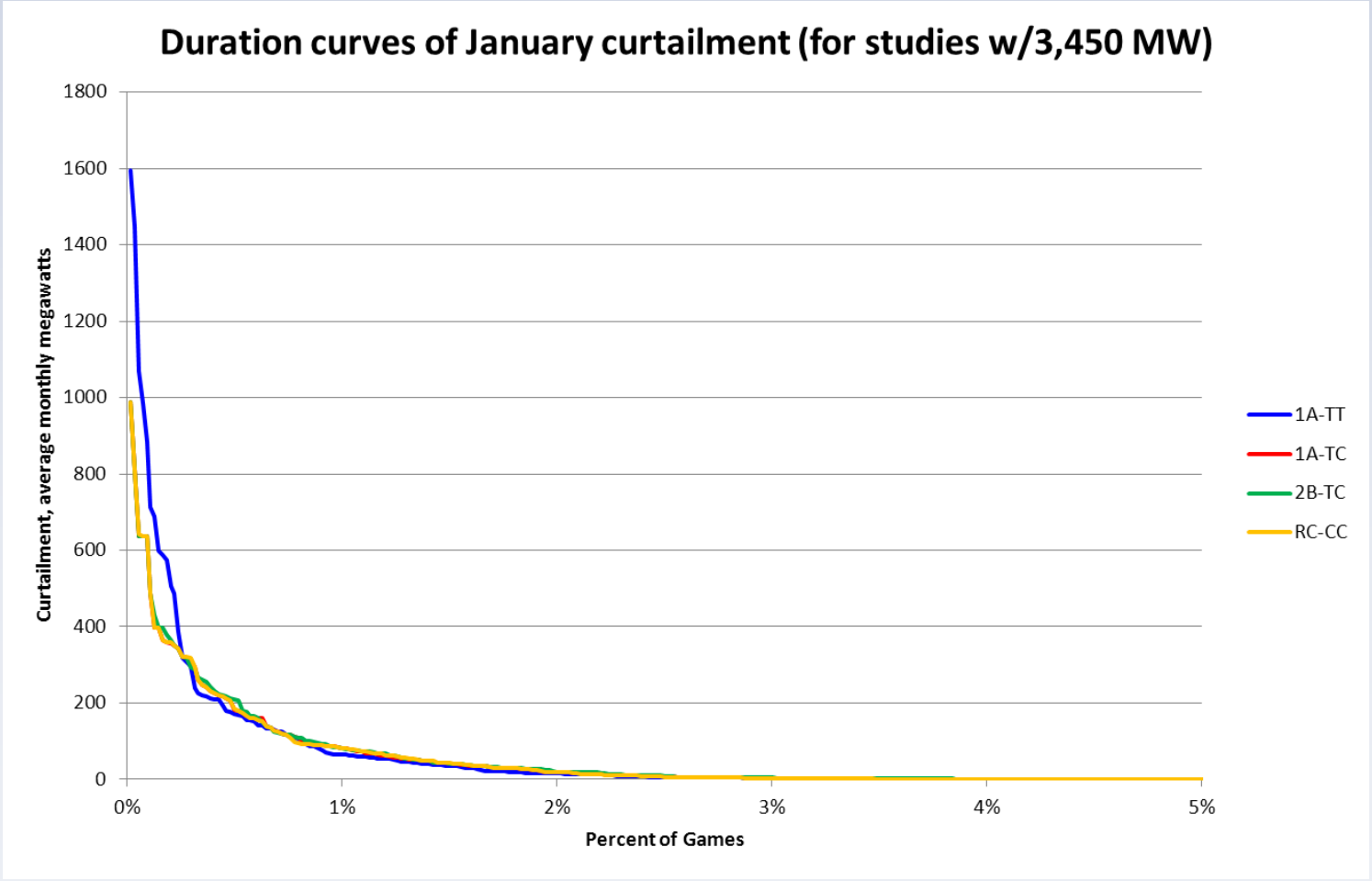
Monthly Duration Curves (2A-TC with 3,450 MW added)



Monthly Duration Curves (2B-TC with 3,450 MW added)



January Duration Curves (All Alternatives)



Tail Event Results (Alternatives)

	Worst Case January aMW-Mth	Equivalent to losing this load for a month:
2A-TT	1,600	Seattle and Eugene
2A-TC	1,000	Tacoma and Eugene
2B-TC	1,000	Tacoma and Eugene
RC-CC	1,000	Tacoma and Eugene

- Results include 3,450 MW of added CTs in all studies
- January tail events are more significant in the study without the Treaty (2A-TT) than those studies with the Treaty
- 2A-TT, 2B-TC, RC-CC have similar tail events
- The worst case scenario has less than a 0.019% chance of occurrence

Summary (Alternatives)

- LOLP Results:
  - Reliability measured by LOLP are similar across all alternatives (less than 1% differences)
  - To achieve the Council's 5% LOLP standard in the 2B-TC alternative requires an additional 285 MW of CTs above the RC-CC
  - 285 MW of CT capital and fuel costs would cost approximately **$77 to $147 million per year** (using the Council's low and high gas price forecast for 2025)
- Tail Event Results:
  - Similar results across all alternatives except for extreme load curtail events (less than 0.5% of games) are greater without a Treaty than with a Treaty

LOLP Results (Components)

	LOLP	MW of CTs required to reach 5% LOLP
E1	91.5%	9,200 MW
E2b	94.7%	9,700 MW
E3	43.7%	5,600 MW
E5	30.2%	4,200 MW
RC-CC	28.3%	3,450 MW

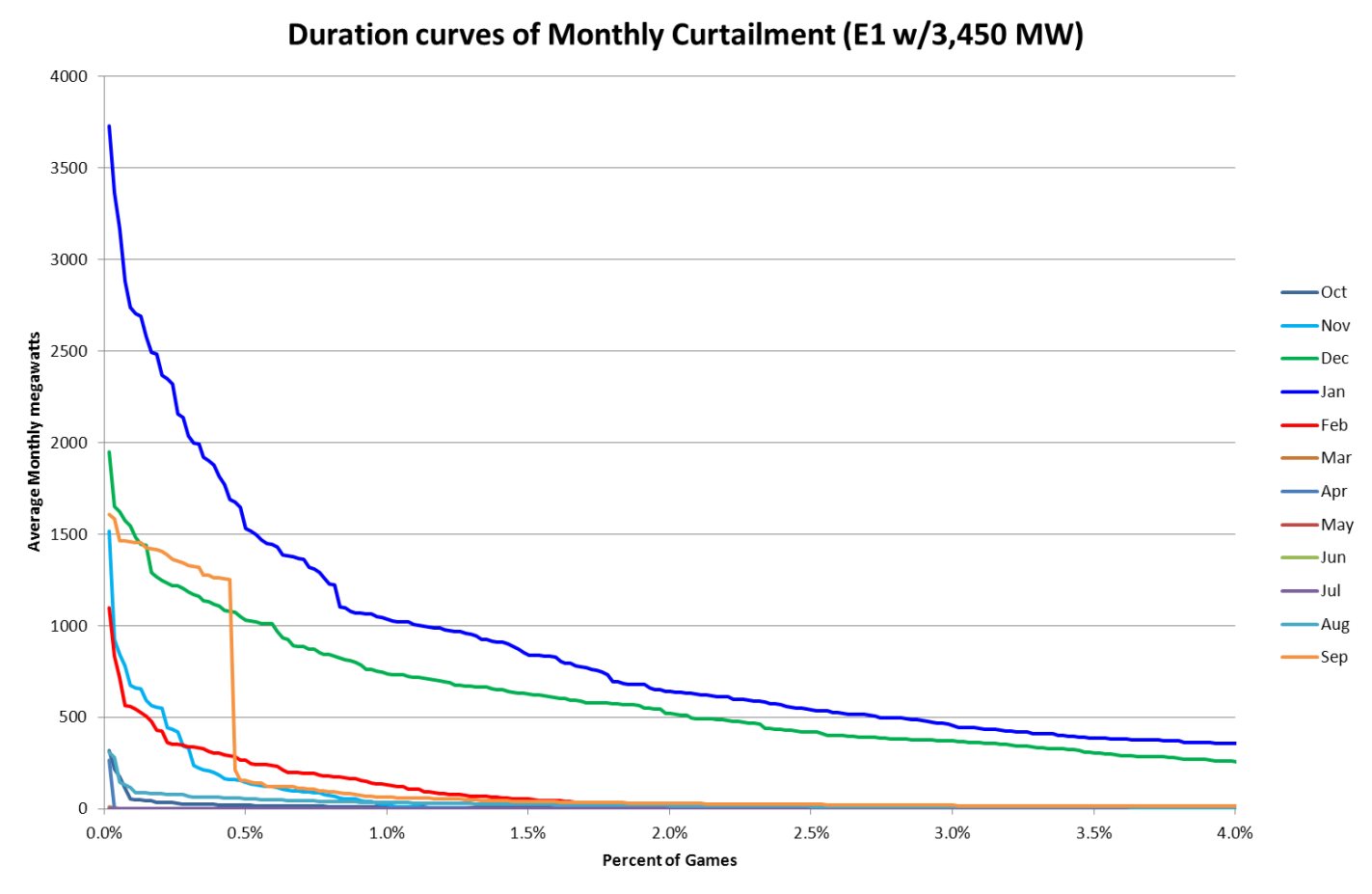
- The LOLP for the E studies ranges from 30.2 to 94.7% - considerably higher than the 5% standard
- To get the E studies down to 5% requires the addition of 4,200 to 9,700 MW of combustion turbines (CT)
- The E5 study required the least amount of CTs (4,200 MW) and the E2b study required the most (9,700 MW)

LOLP Results (Components with 3,450 MW added)

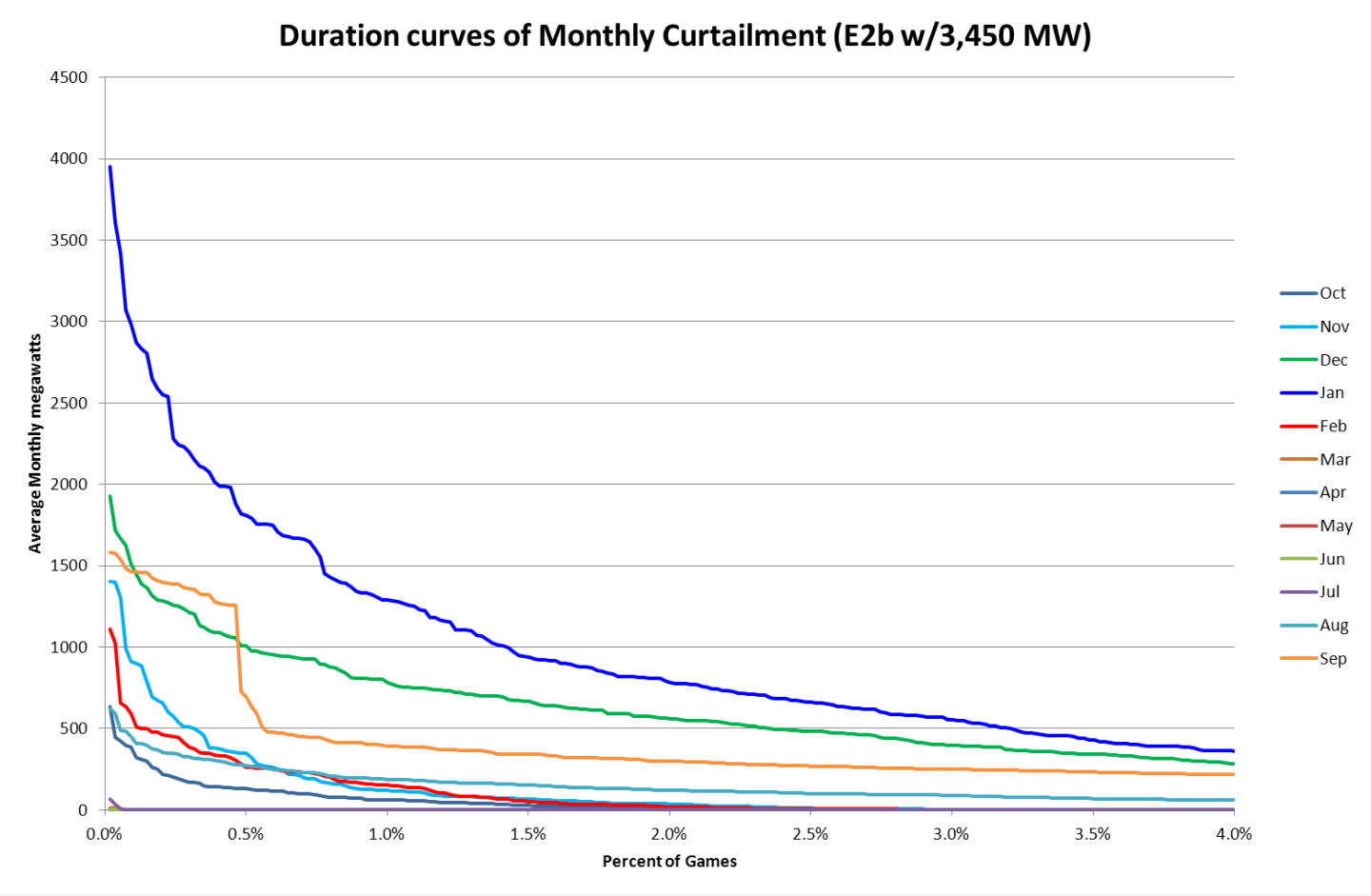
	CT MW added (RC-CC reference)	LOLP with 3,450 MW CT added
E1	3,450 MW	35.3%
E2b	3,450 MW	42.6%
E3	3,450 MW	11.9%
E5	3,450 MW	6.9%
RC-CC	3,450 MW	5.0%

- Using the RC-CC as a reference (3,450 MW to reach 5%), the LOLP of the E studies ranges from 6.9 to 42.6%
- With 3,450 MW of CTs, the E2b study had the highest LOLP (42.6%)

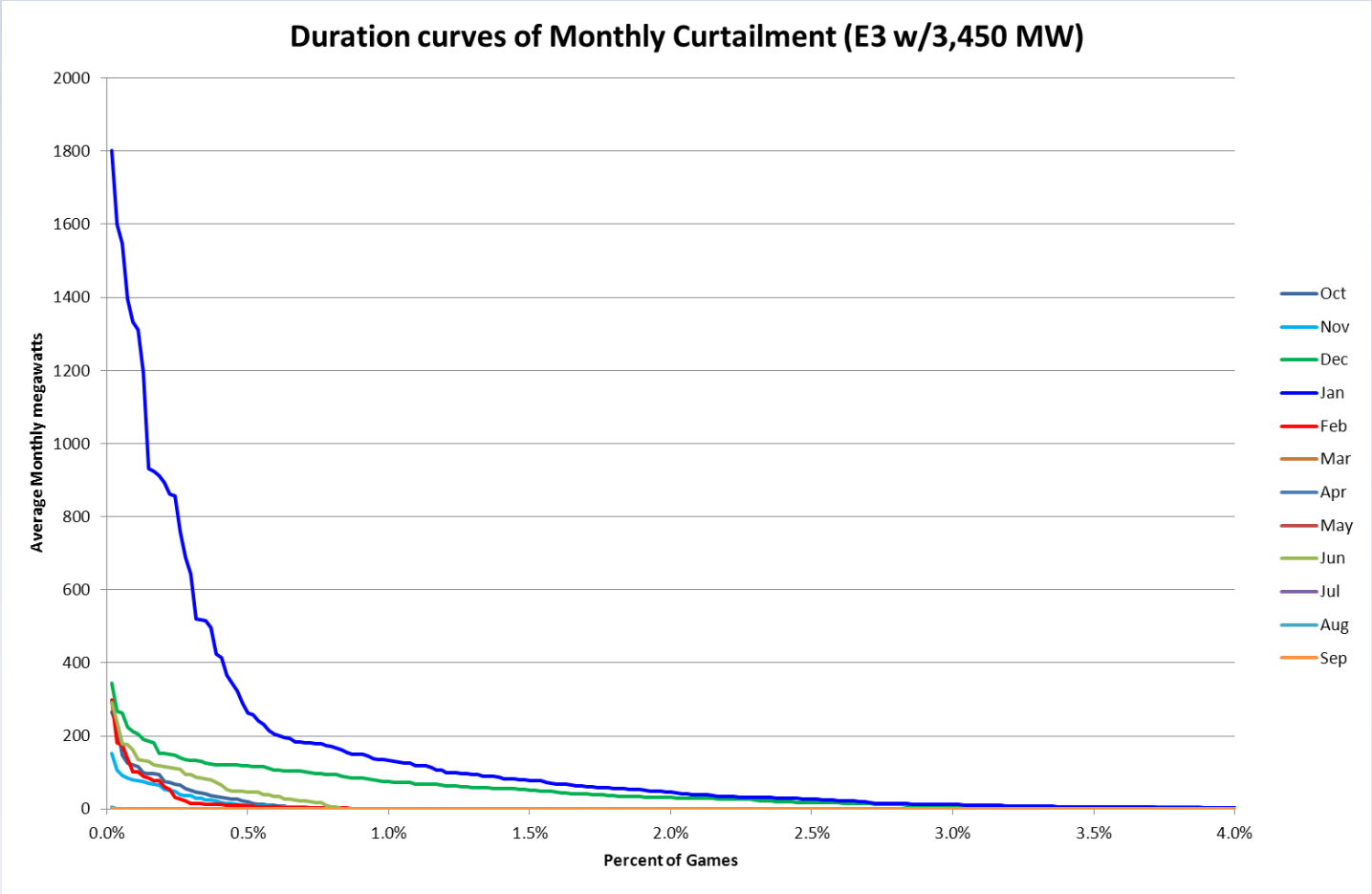
Monthly duration curves (E1 with 3,450 MW CT)



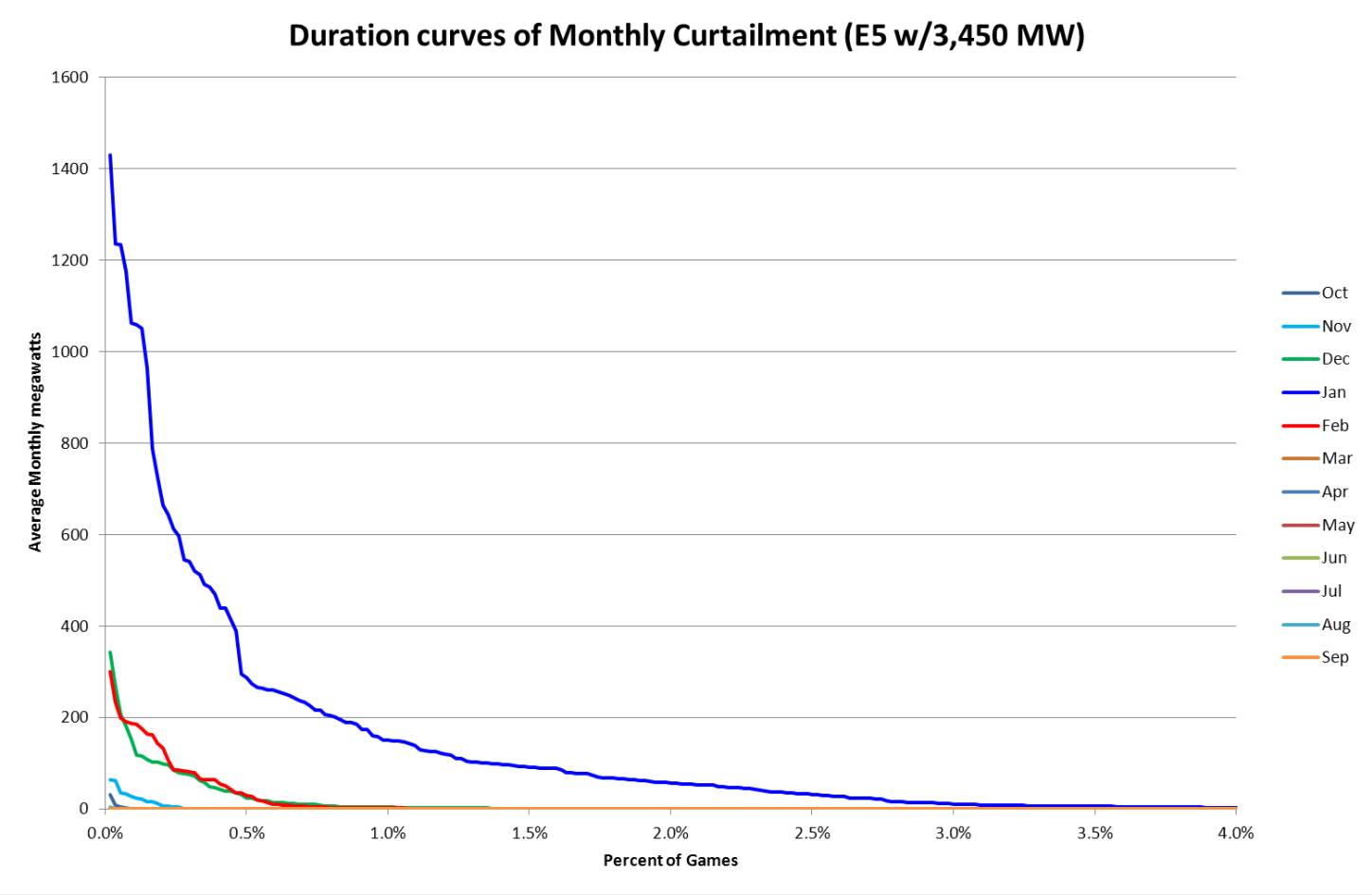
Monthly duration curves (E2b with 3,450 MW CT)



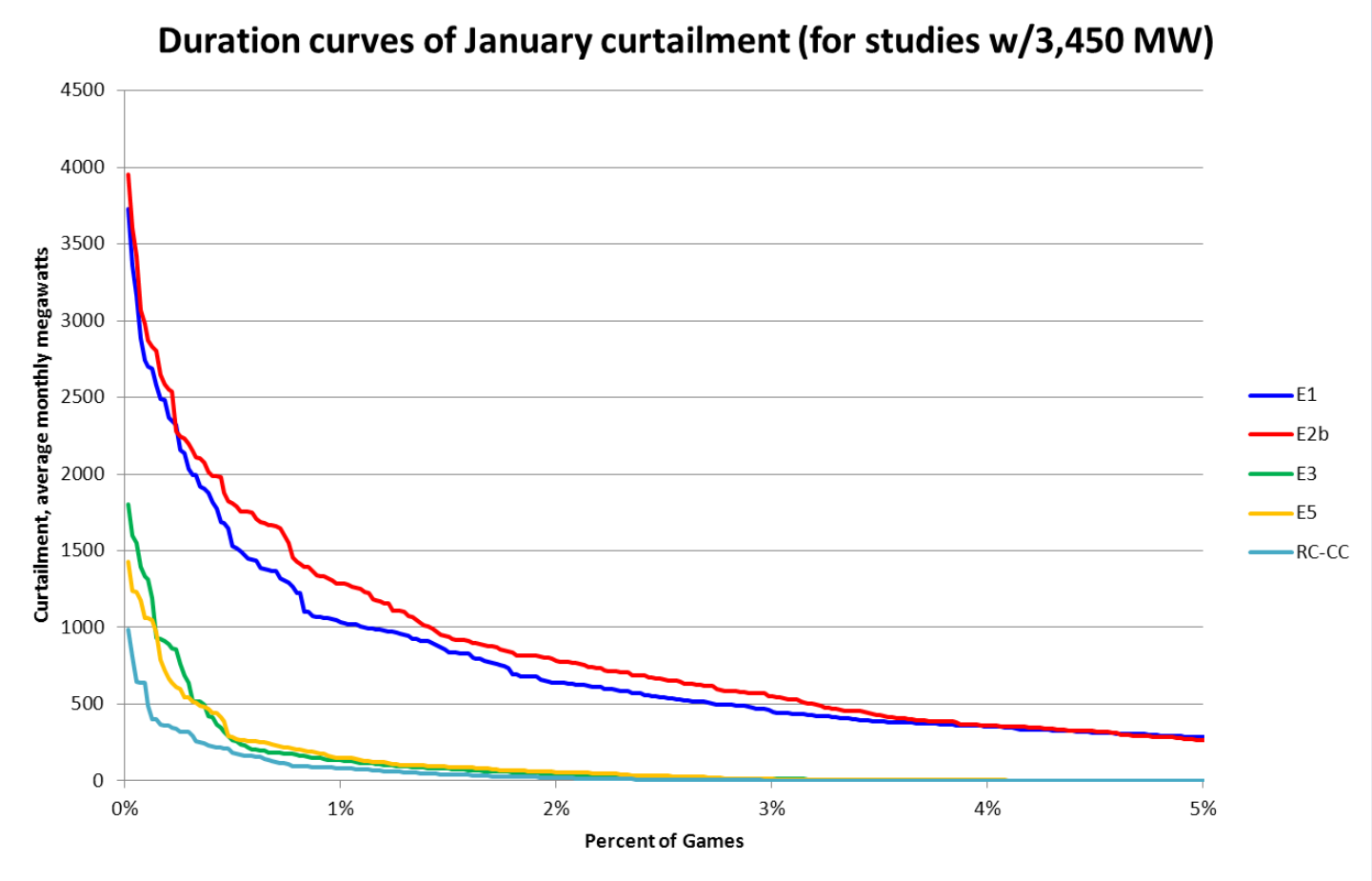
Monthly duration curves (E3 with 3,450 MW CT)



Monthly duration curves (E5 with 3,450 MW CT)



January Duration Curves all Components



Tail Event Results (Components)

	Worst case month (aMW-months)	Equivalent to losing this Load for a month:
E1	3,700 aMW-months	Portland General Electric and Springfield
E2b	4,000 aMW-months	Portland General Electric and Eugene
E3	1,800 aMW-months	Avista and Springfield
E5	1,400 aMW-months	Seattle
RC-CC	1,000 aMW-months	Tacoma and Eugene

Summary (Components)

- LOLP Results:
  - To achieve the Council's 5% LOLP standard the E1 study would require an additional 5,750 MW of new CTs and 2,500 aMW of increased thermal generation above the RC-CC alternative with an approximate annual cost of **$1 to $1.8 billion per year** (using the Council's low and high gas price forecast for 2025)
  - The E2b study would require an additional 6,250 MW of new CTs and 1,800 aMW of increased thermal generation with an approximate cost of **$.95 to $1.5 billion per year** (using the Council's low and high gas price forecast for 2025)
- Tail Event Results:
  - Extreme load curtailment events though unlikely are more evident in E1 and E2b studies and are more severe than the RC-CC alternative